a2 End

device so that a position of the light beam detected at the light spot position sensor always comes to a constant position, the light beam output from the light source and entering the light spot position sensor via the work; and a detector for detecting a surface feature of the work based on a feedback signal from the displacement controller to the displacement device.

Page 5, lines 18-19, delete current paragraph and insert therefore:

a3

Figs. 14A and 14B illustrate the principle of tilt detection by the position sensor;

Page 5, lines 20-21, delete current paragraph and insert therefore:

Figs. 15A and 15B illustrate the principle of gap detection by the position sensor;

Page 5, lines 24-27, delete current paragraph and insert therefore:

Figs. 17A and 17B illustrate an arrangement of an index substrate in an optical encoder according to a further embodiment and the principle of tilt detection thereof;

Page 5, lines 27-28, delete current paragraph and insert therefore:

a4

Figs. 18A and 18B show other examples of photosensitive device patterns for use in the position sensor;

Page 5, lines 29-30, delete current paragraph and insert therefore:

Figs. 19A and 19B show a main part of a non-contact cantilever using a two-dimensional position sensor;

Page 5, line 31, delete current paragraph and insert therefore:

Figs. 20A and 20B show states of the cantilever in use;

Page 6, lines 1-2, delete current paragraph and insert therefore:

a5

Figs. 21A - 21E show several examples of a positional relation of the position sensor to the light source;

Page 6, lines 3-4, delete current paragraph and insert therefore:

Figs. 22A and 22B show a non-contact cantilever containing a displacement device formed therein;

AS End

[Page 6, lines 5-6, delete current paragraph and insert therefore:]

Figs. 23A and 23B show a non-contact cantilever of vertical incident type; and

[Page 6, line 7, delete current paragraph and insert therefore:]

Figs. 24A and 24B show states of the same cantilever in use.

Page 11, lines 5-14, delete current paragraph and insert therefore:

A6

Fig. 9 shows an arrangement of an optical encoder. This optical encoder comprises a scale 50 and a sensor head 54 movably arranged relative thereto, opposing to the scale. The scale 50 in this embodiment is of reflective type and has scale markings or optical gratings 51 formed along a measurement axis x on a scale substrate. The sensor head 54 includes a sensor substrate 52 and alight source 53 . On the sensor substrate 52 , index gratings 55 for modulating a light emitted from the light source and advancing to the scale 50 and a photosensitive device array 56 for detecting a light from the scale 50.

Page 11, lines 15-31, delete current paragraph and insert therefore:

A7

The light spot position sensor 2 as previously described in Figs. 3 and 4 and a light source 57 for providing a light beam are mounted on both sides of the sensor substrate 52 in the sensor head 54 sandwiching the photosensitive device array 56. A state detector 58 for detecting the assembled state of the scale 50 and sensor head 54 from the light spot position detected at the light spot position sensor 2 is provided to configure a state detection system. The light beam from the light source 57 enters the scale 50 at a tilt and the light beam reflected from the scale 50 enters the position sensor 2. In this case, the scale gratings 51 may be formed on the side portion of the scale 50, to which the light beam from the light source 57 enters and alight reflected from the grating surface enters the position sensor 2 . Alternatively, if the scale gratings 51 are not formed on the side portion, a reflective film may be formed continuously along the length of the scale 50 instead of the scale gratings 51.

Page 12, lines 4-10, delete current paragraph and insert therefore:

a8

The light source 57 may be configured as shown in Fig. 10. In this example, a laser diode 60 is located on the sensor substrate 52 to output a light beam laterally. The output light beam is reflected at a mirror 62 then passes through the sensor substrate 52 and enters the scale 50 at a tilt. The mirror 62 can be formed easily with the recent micro-machining technology.

[Page 12, lines 11-16, delete current paragraph and insert therefore:]

Fig. 11 shows another arrangement of the light source 57. In this example, a laser diode 60 is located on a surface of a sensor substrate 52 facing to the scale. The light beam output laterally from the laser diode 60 is reflected at a mirror 63 and enters the scale 50 at a tilt. The mirror 63 may have a reflective surface of concave mirror type to serve also as a lens.

Page 12, line 24 - page 13, line 3, delete current paragraph and insert therefore:

a9

Thus, the assembled state of the optical encoder can be detected by the position sensor 2 and light source 57 mounted on the sensor substrate 52. For example, Fig. 14A shows a normal state (dotted line) of the sensor substrate 52 that is arranged in parallel with the scale 50 and a tilted state (continuous line) of the sensor substrate 52 that is arranged at a tilt. The normal state differs from the tilted state in an incident position of a light beam into the position sensor 2 from the light source 57 as shown in Fig. 14B. Accordingly, a degree of the tilt of the sensor head can be determined by detecting the light spot position.

[Page 13, lines 4-11, delete current paragraph and insert therefore:]

Fig. 15 shows a variable air gap between the sensor head and the scale 50. For example, the gap depicted with a dotted line in Fig. 15A is assumed in a normal state. If the gap reduces as depicted with a continuous line, an incident position of a light spot into the position sensor 2 varies as shown in Fig. 15B. Accordingly, detection of the light spot position can determine a magnitude of the gap between the sensor head and the scale.

Page 13, lines 22-29, delete current paragraph and insert therefore:

In the above embodiments, the light beam from the light source 57 enters the scale 50 at a tilt and the reflected light beam therefrom is detected at the position sensor 2. In another arrangement, the light from the light source 57 may enter the scale 50 at a right angle. Fig. 17 shows such an arrangement. A light spot position sensor 2 is located along one side of a sensor substrate 52 in the sensor head. In addition, a light source 57 is located near the center of the position sensor 2.

Page 13, line 30 - page 14, line 7, delete current paragraph and insert therefore:

In the above arrangement, if the sensor substrate 52 is parallel with the scale 50 as depicted with a dotted line in Fig. 17B, the light beam from the light source 57 enters the scale 50 substantially at right angle and the light reflected therefrom returns along the same path. When the scale 50 tilts as depicted with a continuous line, the light beam enters the scale 50 at a tilt and shifts the position of the spot that enters the position sensor 2. Therefore, the tilt of the sensor head can be determined by detecting this positional deviation.

Page 15, lines 20-31, delete current paragraph and insert therefore:

The optical encoder described above employs the main light source 53 to illuminate the scale for use in displacement detection and the light source 57 for the light spot position sensor. The light source 57 for the light spot position sensor provides a light beam like a laser diode does. Accordingly, it is easy to control the light source 57 so as not to badly affect on displacement detection. To the contrary, the main light source 53 for displacement detection provides an output light that extends to a certain range and enters the scale 50. Therefore, if the light reflected from the scale enters the light spot position sensor, it turns into a possible noise for displacement detection.